Dynamics of Pollen Dispersal and Confinement in U.S. Rice.

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Rice (*Oryza sativa* L.) is arguably, the single most important food crop in the world. In the U.S. it is grown primarily in lowland irrigated areas of Arkansas, Louisiana, Mississippi, Missouri, Texas, and California. Genetically, it is the simplest of all major cereal crops (diploid with 12 pairs of chromosomes), and has served as a useful model for crop genomics research. Outcrossing between fields of rice or between rice and weedy red rice (*O. sativa*) has been increasingly scrutinized since the recent development of herbicide-resistant rice cultivars. Pollen shedding usually occurs slightly before or concurrent with the opening of rice flowers. Thus, rice is primarily self-pollinating because most pollen fertilizes a stigma in the same flower from which it was produced. Outcrossing between adjacent rice plants averages about 0.5% under field conditions. Outcrossing over greater separation distances is mitigated by a combination of factors: 1) each rice flower opens only once, which lasts for about one hour at midday; 2) pollen released into the environment remains viable for only about 10 minutes; and 3) under calm wind conditions, most pollen grains tend to fall near to where they were produced. Genetic background also can affect outcrossing. Thus, cultivated rices (e.g. *O. sativa*) generally outcross less than wild, perennial species (e.g. *O. rufipogon*), and *japonica*-based cultivars, predominantly grown in the U.S., tend to outcross less than their *indica*-based counterparts prevalent in more tropical areas of the world. Floral characteristics such as large anthers or lengthened filaments that tend to release great quantities of pollen into the environment, and large, extruding stigmas that can readily intercept foreign pollen grains can be associated with increased outcrossing rates in some cultivars. Environmental factors can influence outcrossing. For example, outcrossing is typically greatest in the direction of the prevailing wind. Conditions such as bright sunlight and warm temperatures that increase the degree of flower opening, and high relative humidities that increase pollen longevity facilitate natural outcrossing as well as successful manual crossing performed by rice breeders. As indicated in a recent review, outcrossing between herbicide-resistant or non-resistant rice cultivars and other rice cultivars is frequently undetectable at separation distances greater than 2 m and seldom detectable at distances greater than 10 m. In contrast, outcrossing between a prolific pollen-producing rice and perennial wild rice (*O. rufipogon*) has been as high as 2.2% and was detectable at 43 m. Thus, it must be emphasized that a lack of detectable outcrossing at great distances does not necessarily equate to zero outcrossing. In order to minimize outcrossing and maintain genetic isolation between certified U.S. rice fields, seed laws have traditionally required a minimum of 5 to 6 m between different drill-seeded cultivars (precise seed placement) and 30 m between aerially-seeded cultivars (imprecise seed placement). Ultimately, pollen confinement regulations must be a compromise between restrictions that guard against extremely rare biological events (i.e. outcrossing over great distances) and practical necessities of crop management and economics. A realistic accommodation of these competing interests will combine both scientific and public policy considerations.